VSD
(Ventricular Septal Defect)

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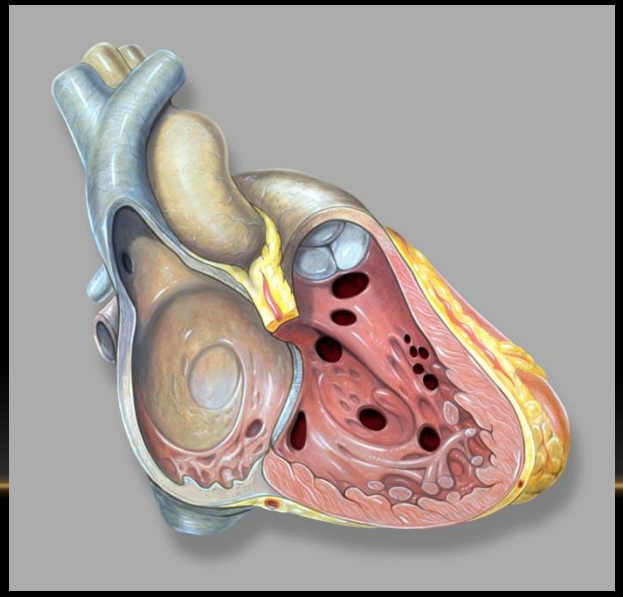
최은석


ΑΩ

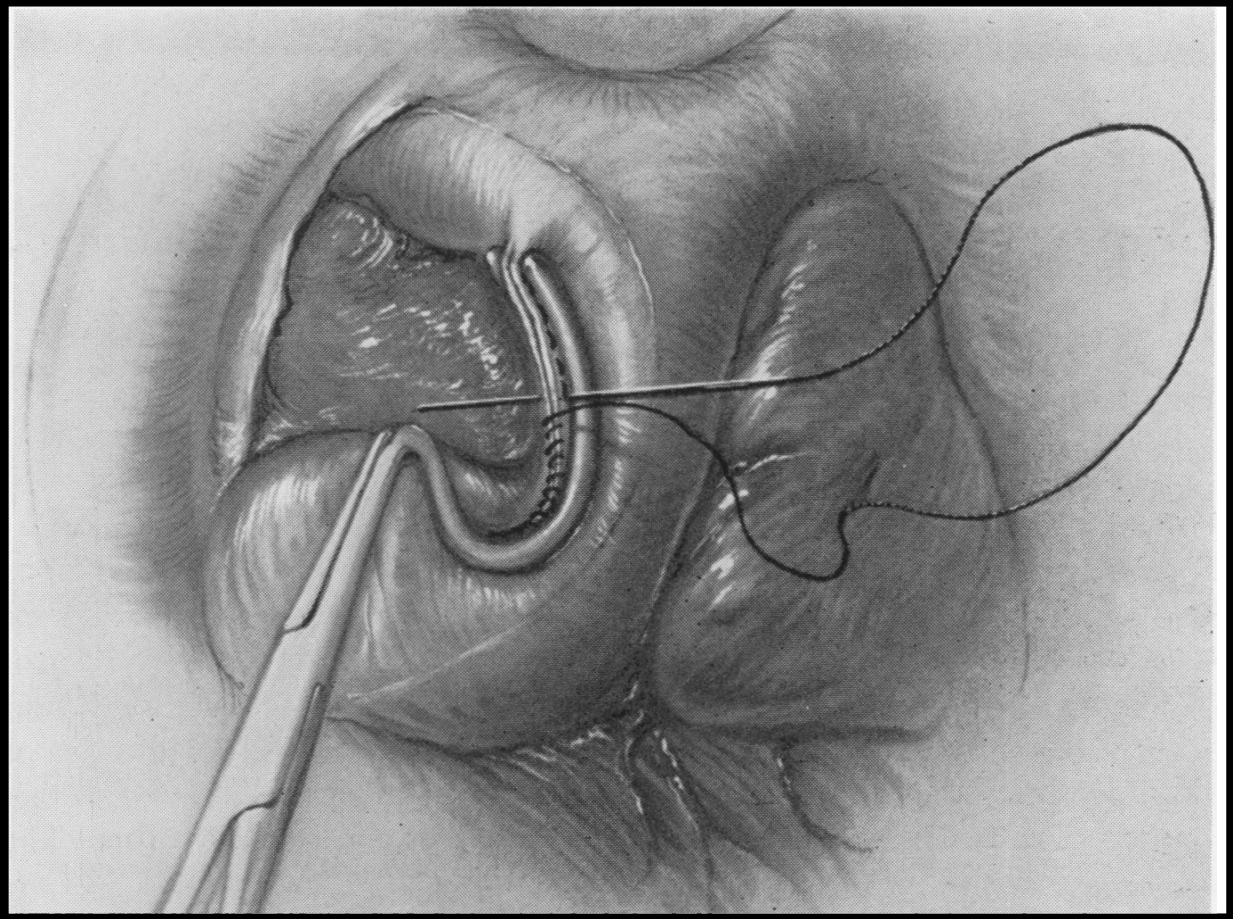
VSD

- A hole between the LV and RV
- Isolated or with a variety of anomalies



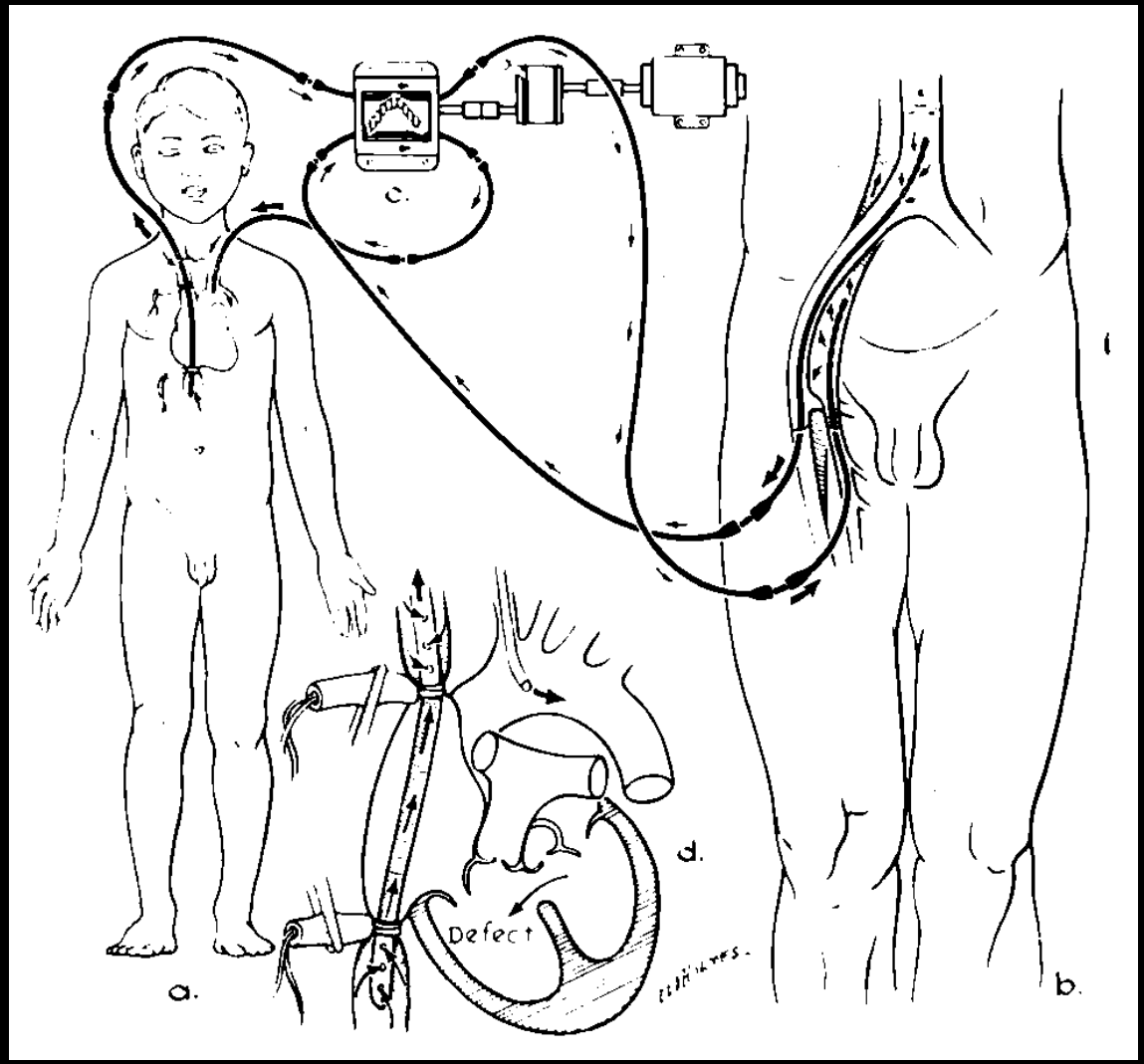
History

PAB



Surg Gynec Obst 1952;95:213

History



Ann Thorac Surg 1986;41:4-21

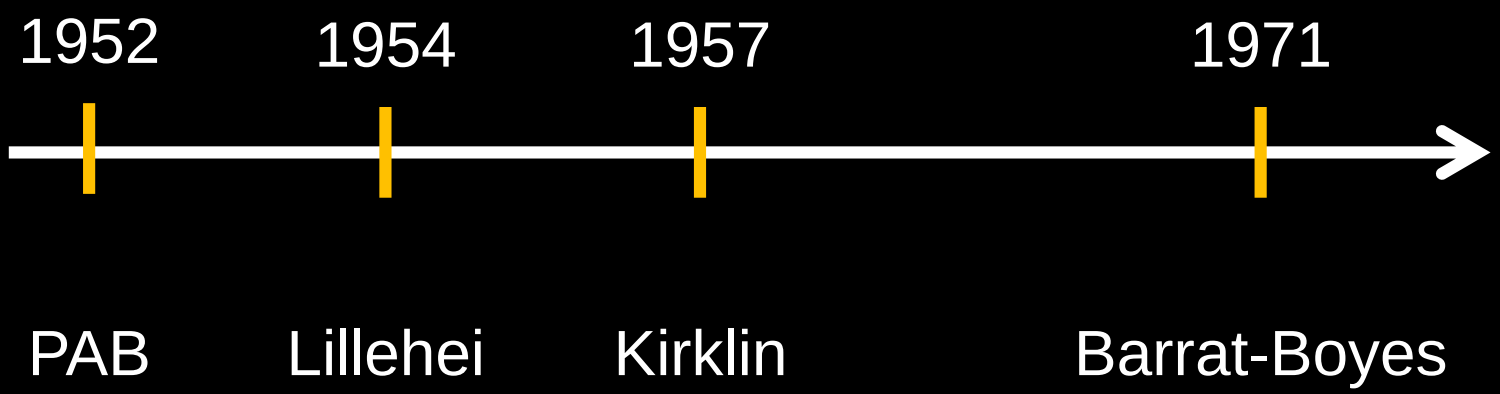
Table 2. Results of Direct-Vision Intracardiac Operations with Cross-Circulation on 45 Patients from March 26, 1954, to July 19, 1955[a]

Abnormality	Corrective Operation	No. of Patients	Mortality	
			Hospital	Late (30-yr)
VSD	Suture closure	27	8	2
PDA (with severe pulmonary hypertension)	Exploratory ventriculotomy; division of ductus	1	0	0
Tetralogy of Fallot	Suture closure of VSD; repair of infundibular/valvular pulmonary stenosis	10	5	3
Atrioventricularis communis	Closure of ostium primum, VSD; repair of valvular deformities	5	3	1
Isolated infundibular pulmonary stenosis	Resection of infundibulum	1	0	0
Pulmonary stenosis, ASD, anomalous pulmonary venous drainage	Pulmonary valvotomy; ventricular and atrial cardiotomies; transposition of pulmonary veins; closure of defects	1	1	0
Totals		45	17	6

[a]Cross-circulation was used exclusively from its inception through February, 1955. Beginning March 1, 1955, other bypass methods (bubble oxygenator, dog lung oxygenator, arterial reservior) were employed for lower risk patients. Cross-circulation was reserved for higher risk patients. By July, 1955, the bubble oxygenator had become the sole method.

Ann Thorac Surg 1986;41:4-21

History

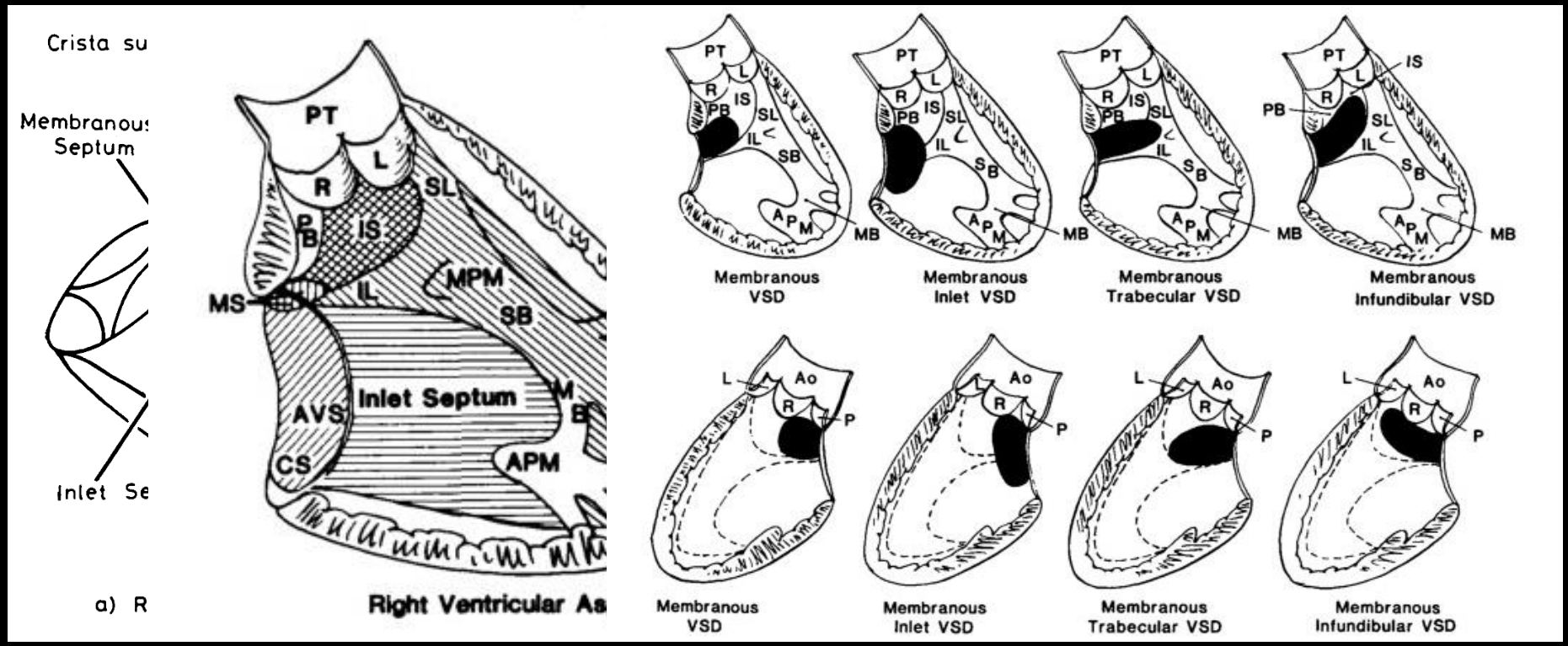


Anatomy

- Right ventricular septum
- Tricuspid valve
- Conduction system

Right ventricular septum

- The membranous septum
- The inlet septum or atrioventricular canal
- The muscular septum
- The trabecula septomarginalis
- The conal septum or infundibular septum

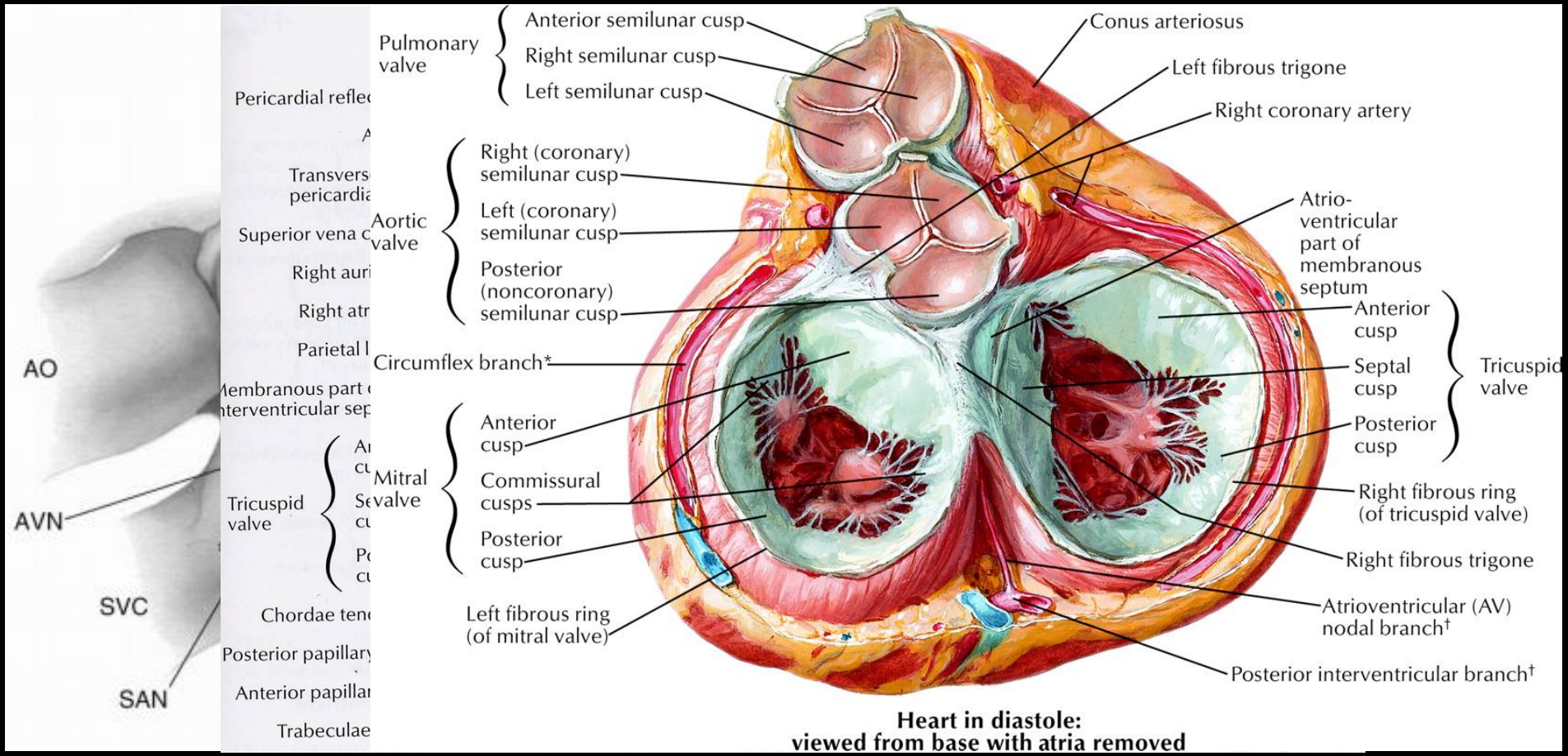


Mayo Clin Proc 1985;60(11):741-52

Br Heart J 1980;43:332-343

Tricuspid valve

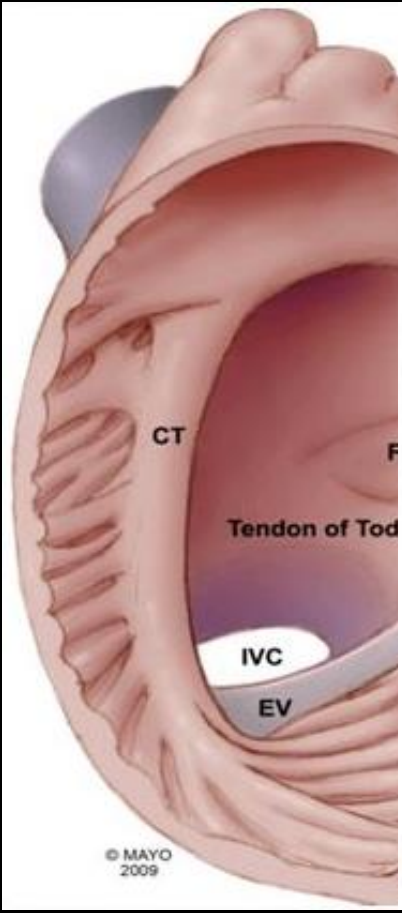
- Three leaflets
  - Anterior, septal, posterior
- Papillary muscles
  - Anterior, posterior, septal (medial)



Heart in diastole:
viewed from base with atria removed

Conduction system

- AV node
  - Triangle of Koch
    - Tendon of Todaro
    - Orifice of the coronary sinus
    - TV annulus
- Common AV bundle of His
  - Posteroinferior rim of the VSD in PM VSD


CT
Tendon of Tod
IVC
EV
© MAYO
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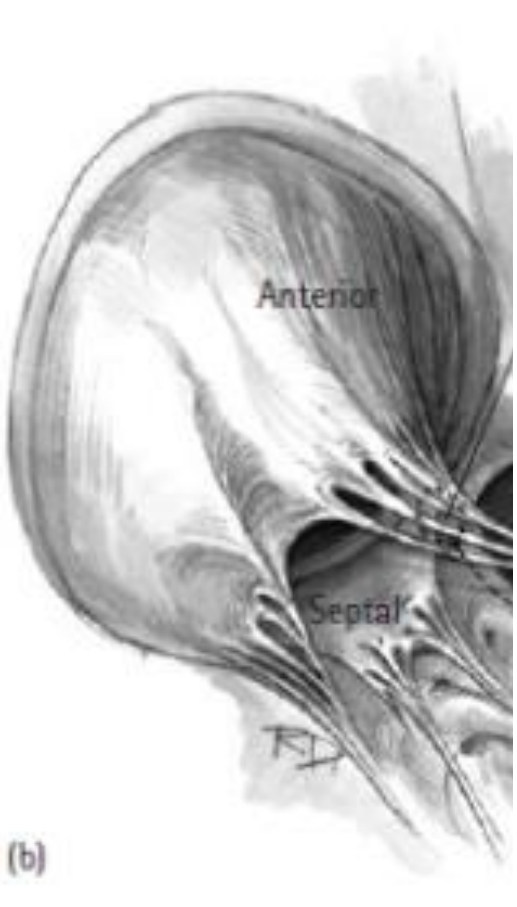
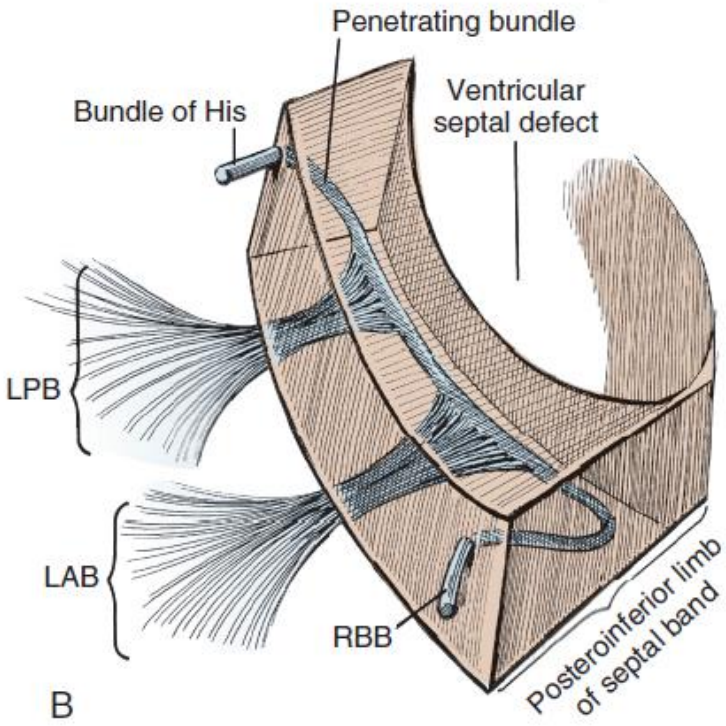
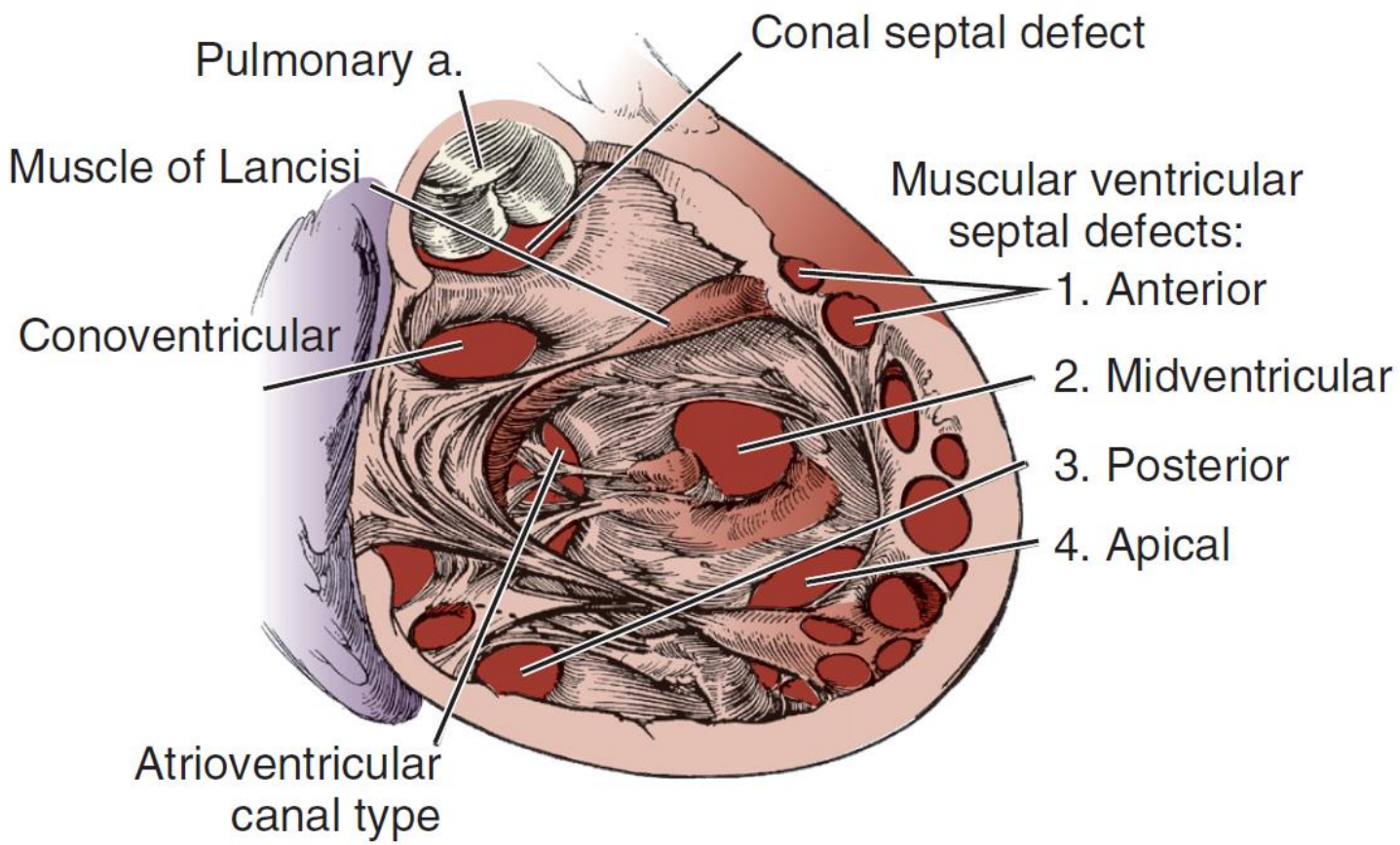

Anterior
Septal
(b)


Penetrating bundle
Bundle of His
Ventricular
septal defect
LPB
LAB
RBB
Posteroinferior limb
of septal band
B

Classification of VSD

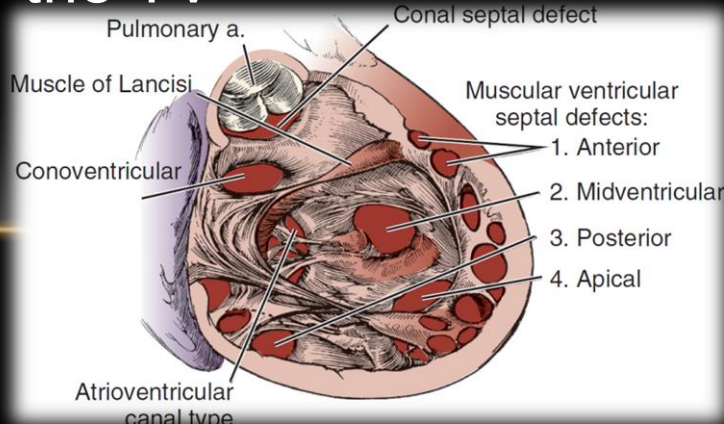
- Conoventricular (or membranous) defect
  - Perimembranous (PM)
- Conal (or outlet) VSDs
  - Subarterial (SA)
- Inlet (or AV canal type) VSDs
- Muscular VSDs (single or multiple)

Defects with partly
A. Subarterial infun
B. Perimembranou
including
atrioventricular
canal defect



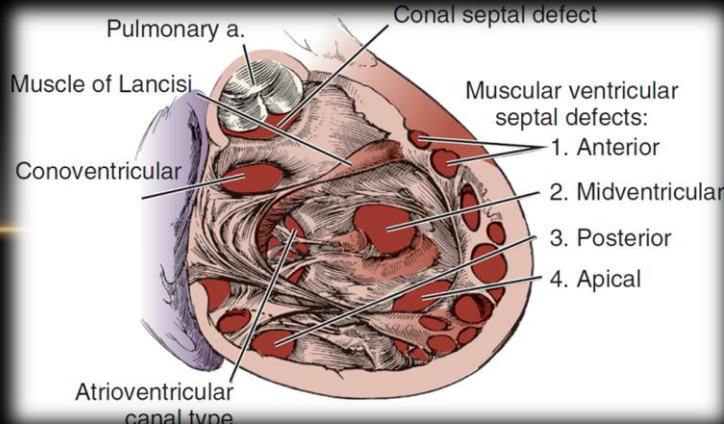
Classification of VSD

- Conoventricular (or membranous) defect: 80%
  - The membranous septum
    - Perimembranous or paramembranous
  - Landmarks
    - Anteroseptal commissure of the TV
    - NCC of AV



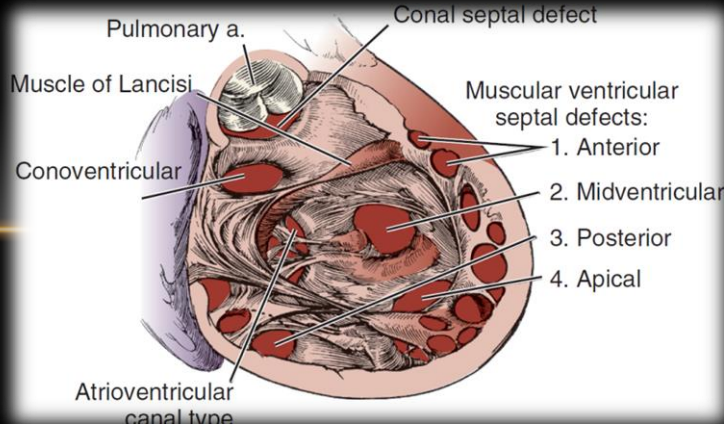
Classification of VSD

- Conoventricular (or membranous) defect
  - Malalignment: conal septum
    - Conal septal plane to ventricular septal plane
    - Anterior: ex) TOF
    - Posterior: ex) IAA



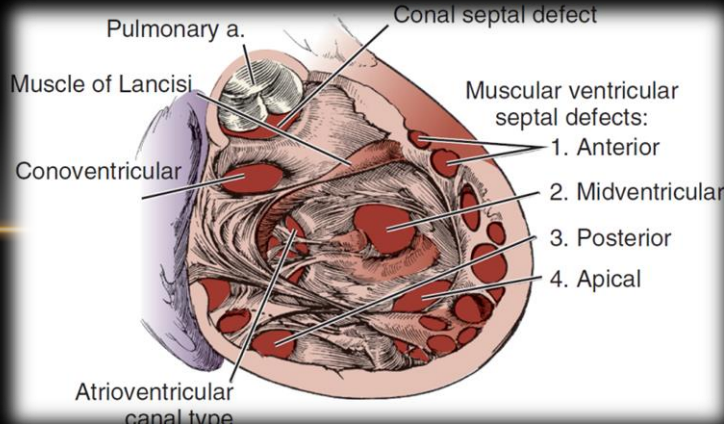
Classification of VSD

- Conal (or outlet) VSDs: 8%
  - Entirely surrounded by muscle
    - Muscular conal VSD
  - Limited upstream by aortic or pulmonary annuli
    - Subarterial VSD



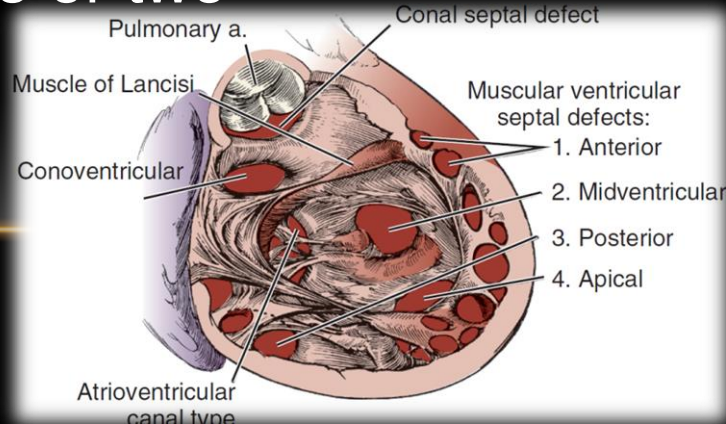
Classification of VSD

- Inlet (or AV canal type) VSDs: 6%
  - Part or all of the AV canal (inlet) septum
  - Immediately underneath the septal leaflet
  - No tissue in between



Classification of VSD

- Muscular VSDs (single or multiple): 10%
  - Described by location
    - Anterior / Midventricluar / Posterior / Apical
  - Through LV side
    - Converge into either a single or two



Associated Defects

- Almost half of patients undergoing surgery for VSD
  - PDA: With large VSD by EchoCG
  - Coarctation of the aorta: More L – R shunt
  - LVOTO: discrete fibromuscular membrane
  - ASD, RVOTO, …

Pathophysiology

- Shunt direction and magnitude
  - Depends on
    - Size of the defect
    - Pressure gradient
    - Relative compliance of both ventricles
    - Pressure relationship during the cardiac cycle

Pathophysiology

- Shunt direction and magnitude
  - Nonrestrictive
    - RV pressure = LV pressure
    - Qp/Qs depends on the ratio of PVR to SVR
  - Restrictive
    - VSD offers resistance to flow

Pathophysiology

- Sequelae of Left-to-Right shunting
  - Increased pulmonary blood flow
    - LA and LV enlarged
    - LAP↑ → pulmonary edema → pulmonary infection
    - Lung compliance↓ → The work of breathing↑
    - Failure to thrive

Pathophysiology

- Sequelae of Left-to-Right shunting
  - Development of pulmonary vascular disease
    - Pulmonary blood flow ↓ → Sx improvement
    - Eisenmenger complex
      - Fixed pulmonary hypertension
      - RV hypertrophy, Normal-sized LV
      - Often inoperable

Pathophysiology

- Pulmonary vascular disease
  - Pathology of hypertensive PVD
    - Heath and Edwards
    - Correlate the PVR of patients with VSD with histologic severity of pulmonary vascular changes

The Pathology of Hypertensive Pulmonary Vascular Disease

A Description of Six Grades of Structural Changes in the Pulmonary Arteries with Special Reference to Congenital Cardiac Septal Defects

By DONALD HEATH, M.D., AND JESSE E. EDWARDS, M.D.

Progressive histologic changes occur in the pulmonary arteries and arterioles, as a complication of chronically elevated pulmonary arterial blood pressure, in patients with congenital septal defects of the heart. This progression is so stereotyped as to allow a division of the structural effects into 6 grades. The histologic features of each grade are described in detail in this communication. These results afford a basis for comparing the magnitude of these changes to the clinical findings.

Circulation 1958;18:533-547

TABLE 1.—*Basis of Grades of Hypertensive Pulmonary Vascular Disease Found in Association with Large Ventricular Septal Defects and Functionally Related Diseases*

	Grade of hypertensive pulmonary vascular disease					
	1	2	3	4	5	6
Type of intimal reaction	←—None —→	←———	———	—Cellular———	———	———→
			←———	— Fibrous and fibroelastic—	———	———→
				←——— "Plexiform lesion" ———		———→
State of media of arteries and arterioles	←———	———	——— Hypertrophied ———		———	———→
			←———	— Some generalized dilatation ———		———→
				←——— Local "dilatation lesions" ———		———→
					←——— P H * ———	———→
						←—N A †—→

* Pulmonary hemosiderosis associated with distended, thin-walled, arterial vessels throughout the lung.
† Necrotizing arteritis.

Circulation 1958;18:533-547

Indications for Surgery

- Natural history of VSD
  - Most membranous and muscular VSDs
    - Tends to close spontaneously
  - Malalignment conoventricular or inlet VSDs
    - Unlikely to close spontaneously

Indications for Surgery

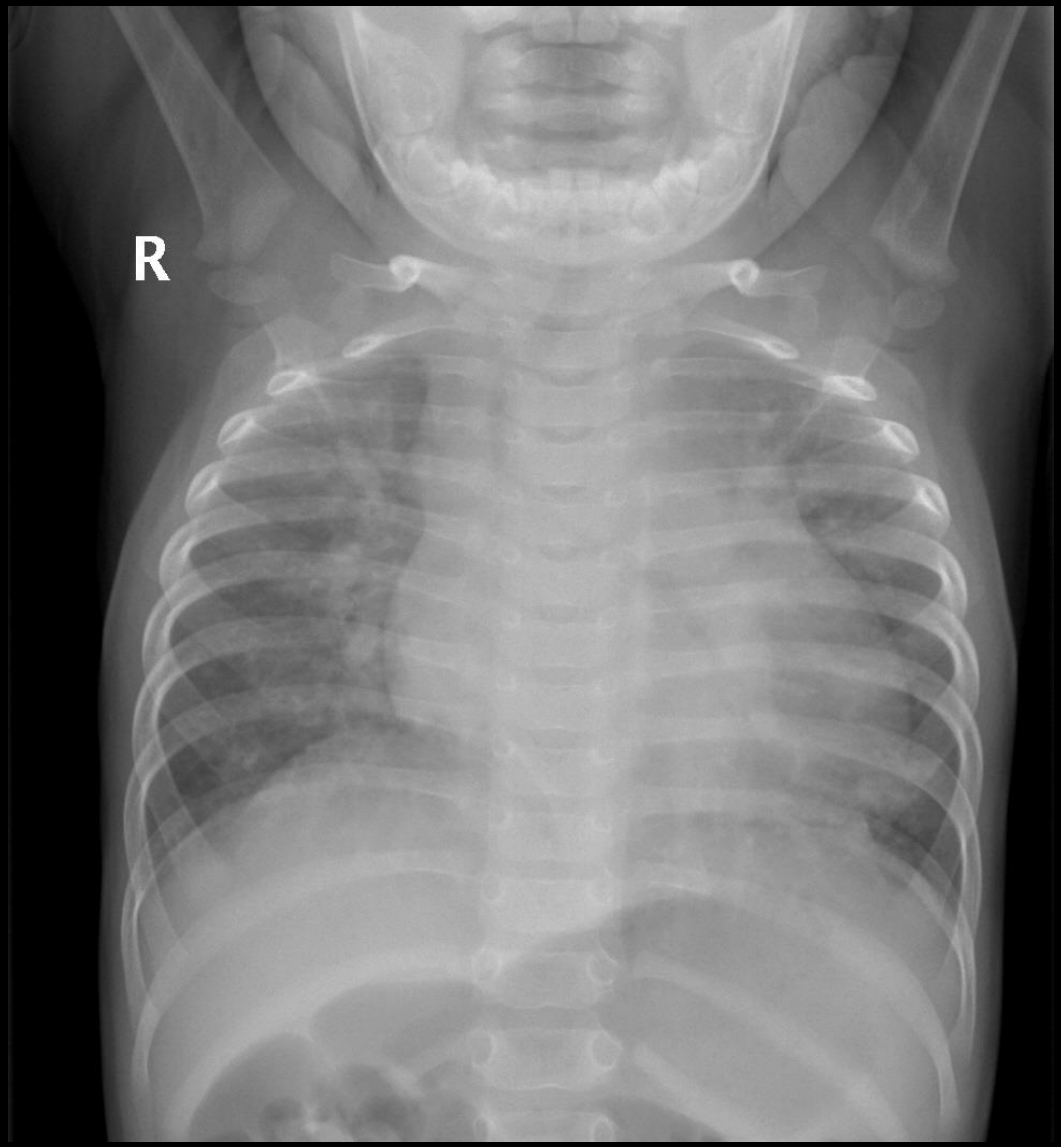
- Congestive heart failure
- Increasing aortic cusp prolapse and regurgitation

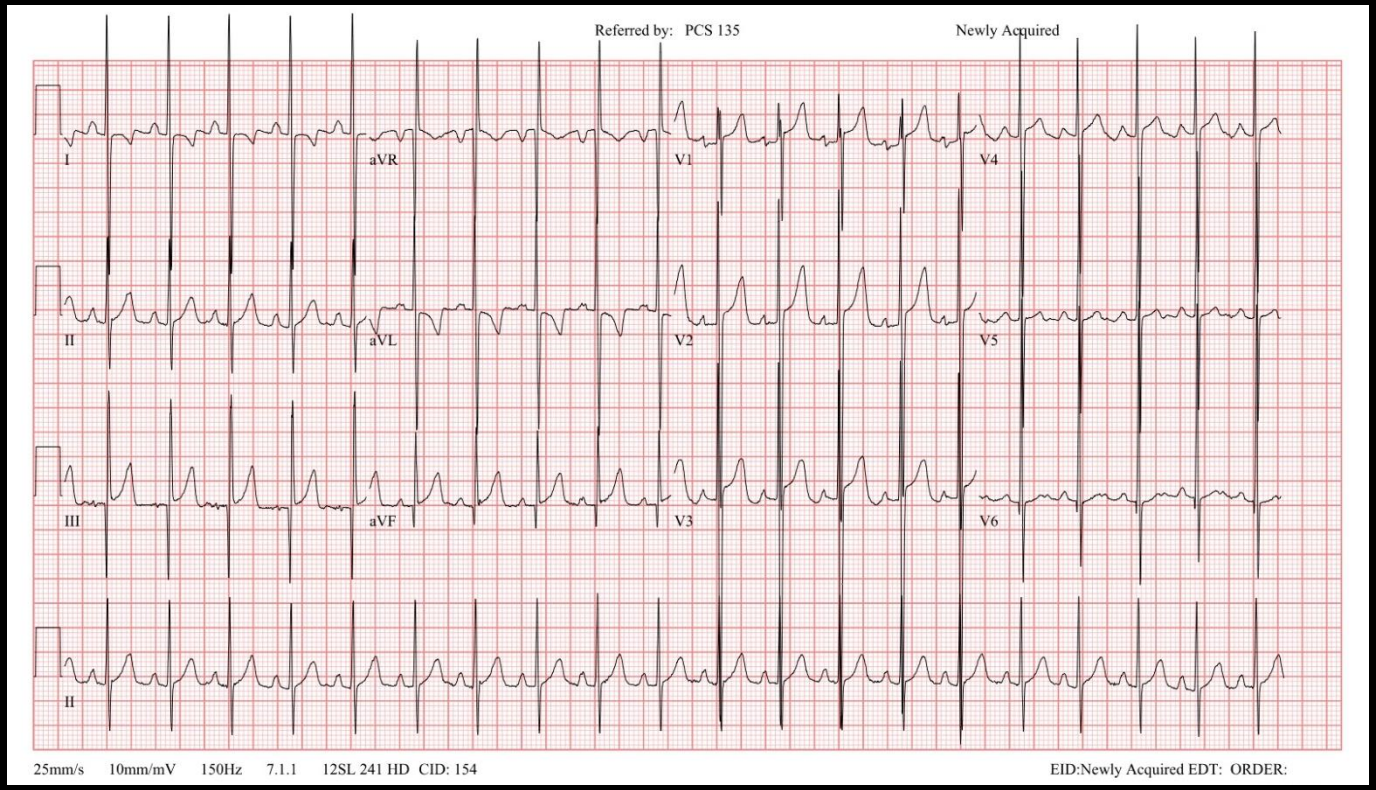
Diagnosis

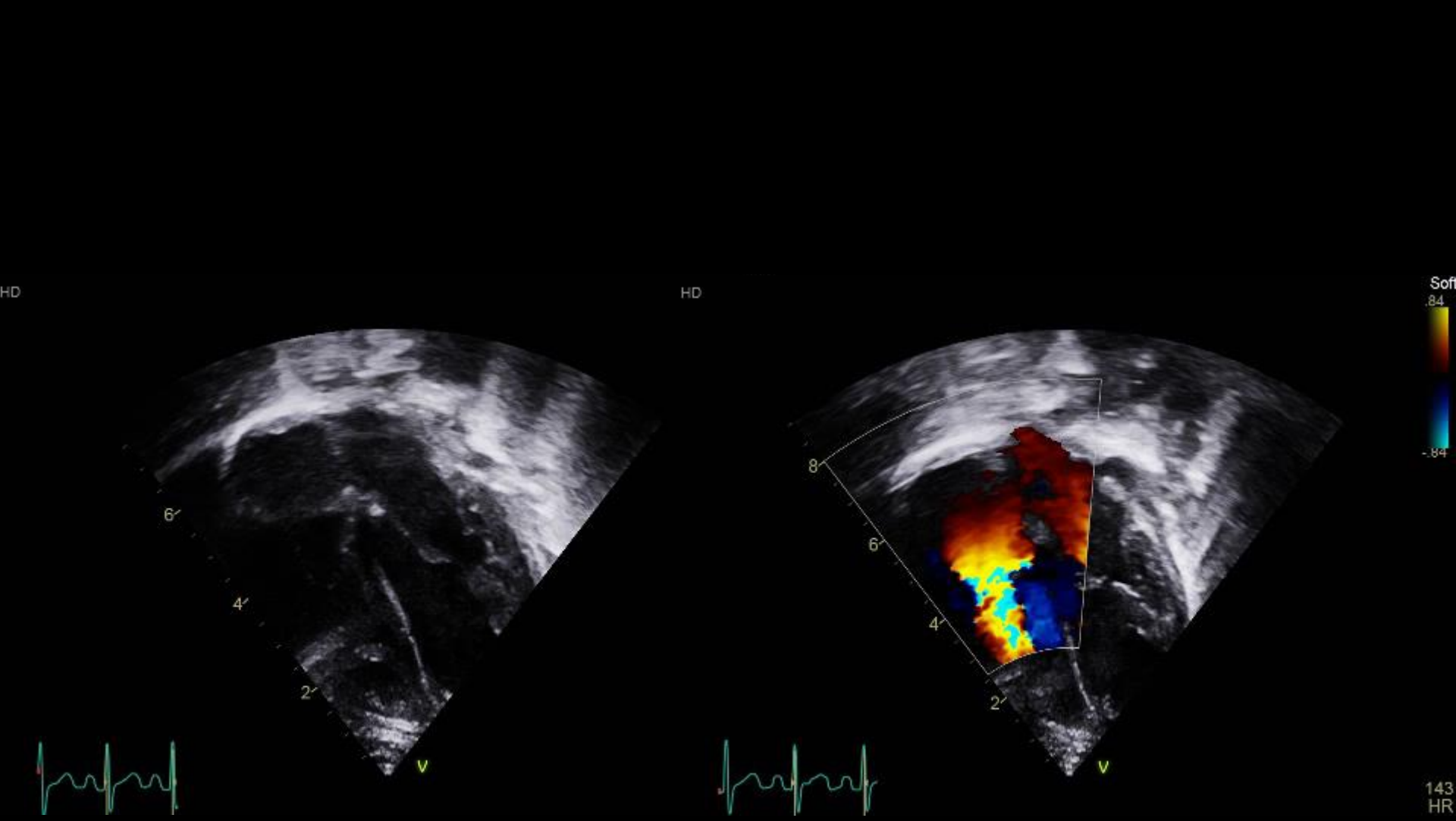
- Symptoms
  - Tachypnea, profuse sweating during feeding
  - Growth failure
- P/E
  - bulging precordium, pansystolic murmur,
  - enlarged liver, thready pulses

Diagnosis

- Chest film
  - Large central and peripheral PA
  - Enlarged LA and LV
- ECG
  - Biventricular hypertrophy
- Echocardiography: essential
- Cardiac catheterization

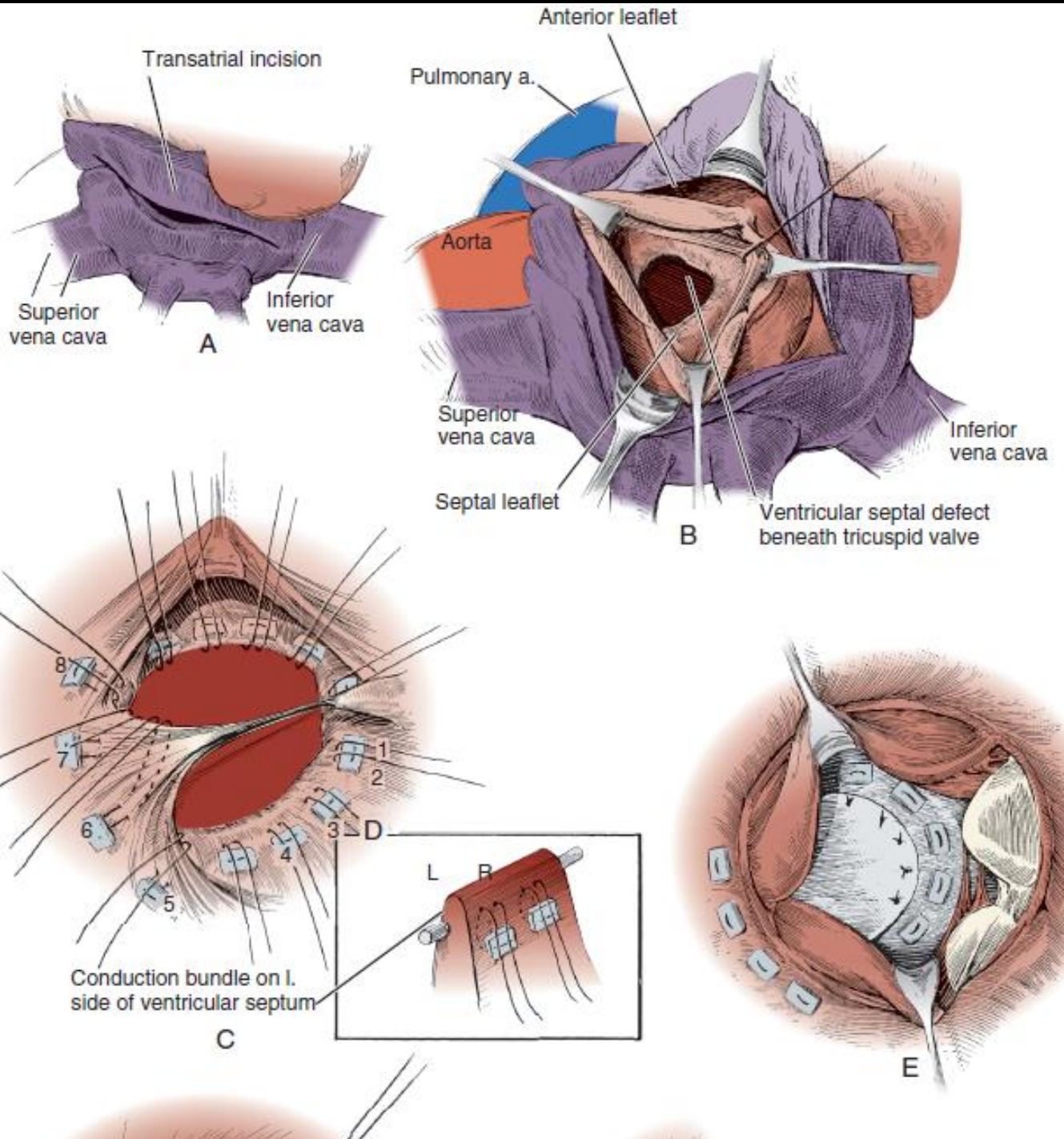

R

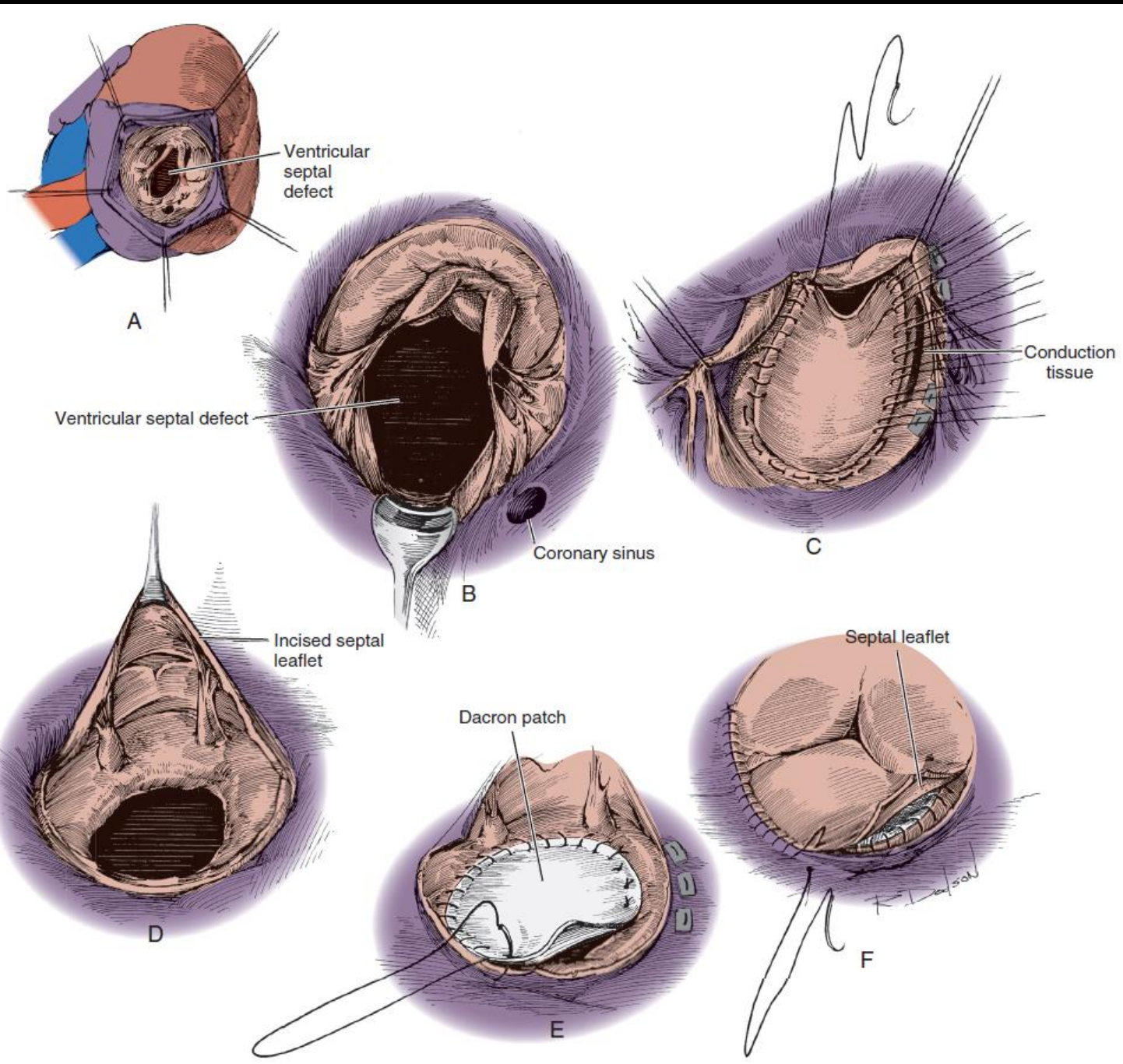

Referred by: PCS 135
Newly Acquired
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
25mm/s 10mm/mV 150Hz 7.1.1 12SL 241 HD CID: 154
EID:Newly Acquired EDT: ORDER:

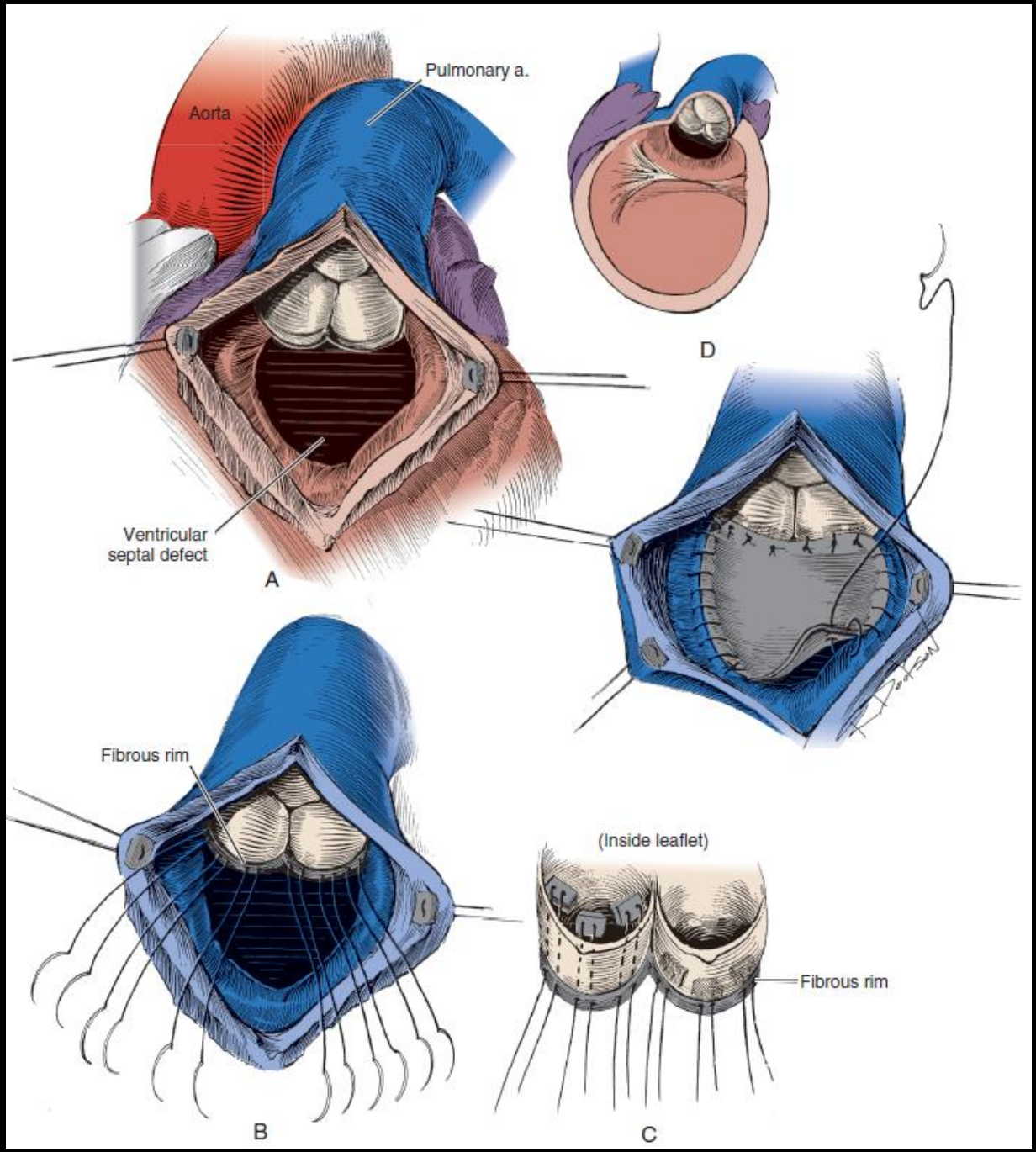

HD
6
4
2
V
HD
8
6
4
2
V
Soft
.84
-.84
143
HR

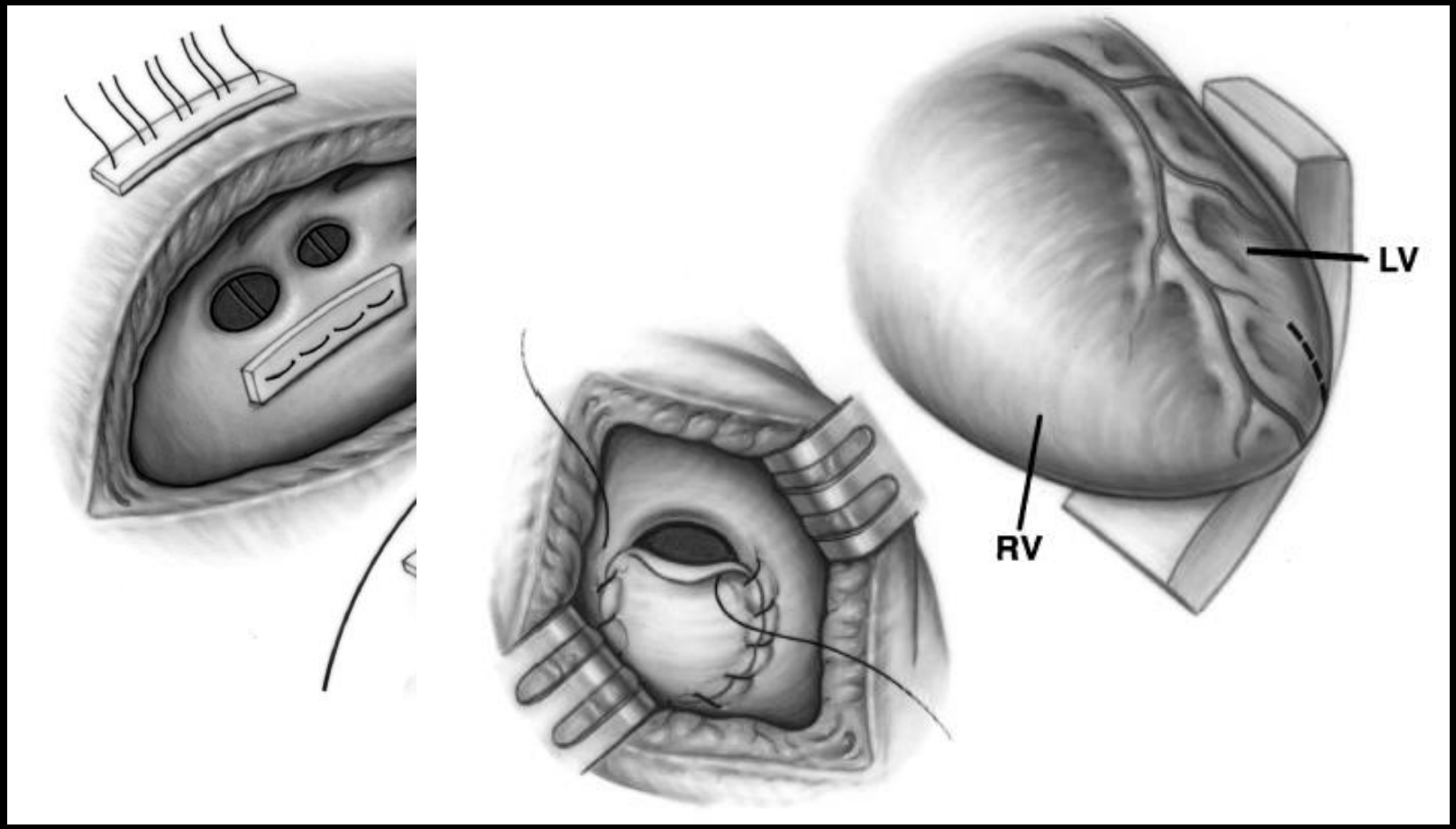
Surgical Technique

- Moderate hypothermia
- Approach
  - RA / MPA / RV / LV
- TV: retraction or detachment
- AV: infusion of CP solution
- Interrupted or continuous suture


Transatrial incision
Superior vena cava
Inferior vena cava
A
Anterior leaflet
Pulmonary a.
Aorta
Superior vena cava
Inferior vena cava
Septal leaflet
Ventricular septal defect beneath tricuspid valve
B
8
7
6
5
4
3
2
1
D
L
R
Conduction bundle on l. side of ventricular septum
C
E

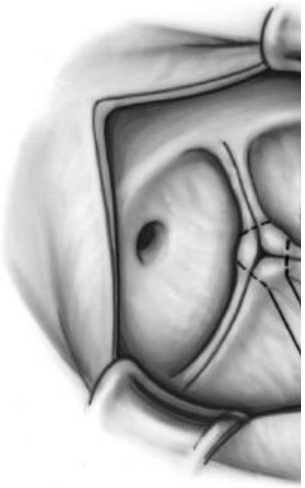

Ventricular septal defect
A
Ventricular septal defect
Coronary sinus
B
Conduction tissue
C
Incised septal leaflet
D
Dacron patch
E
Septal leaflet
F

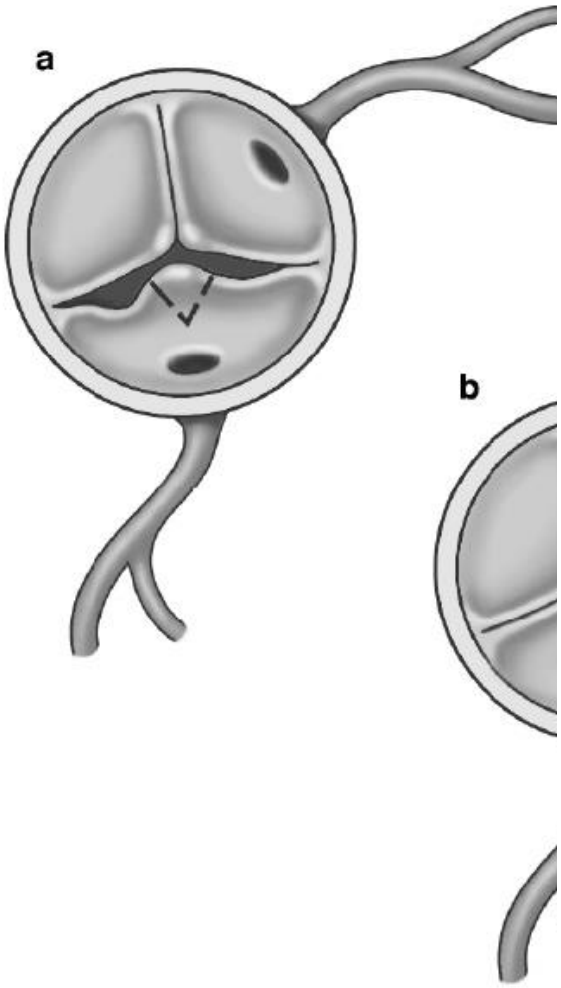

Pulmonary a.
Aorta
Ventricular septal defect
A
D
Fibrous rim
B
(Inside leaflet)
Fibrous rim
C

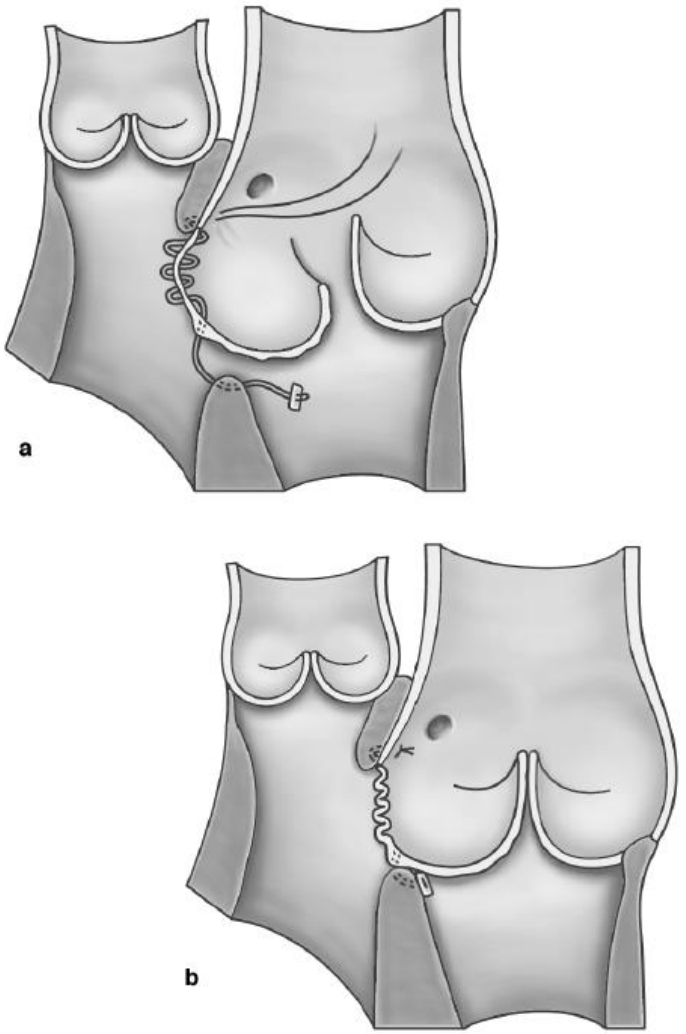

LV
RV

VSD with AI

- Usually older children
- RCC or NCC prolapse into
  - Bernoulli effect
- > moderate AI with cusp retraction
  - Require AV repair




a
b


a
b

VSD with prior banding

- Multiple muscular VSDs : m/c
- RV hypertrophy
  - Difficult identification of VSDs
- Operative techniques
  - Conventional closure
  - Sandwich technique
  - Intraop device closure

Postoperative Care

- Special treatment is usually not required
- In the unusual case of low cardiac output
  - It is the surgeon's responsibility
  - Bedside echocardiography
    - Large residual VSD
    - Injury to the aortic cusp
    - Tricuspid regurgitation

Postoperative Care

- Complete AV dissociation after CPB
  - Temporary pacing
  - Usually permanent beyond 10 to 14 days
- Pulmonary hype
  - In older patie
  - Prophylactic

Precipitating factors	Management
Tracheal suction Acidosis Hypoxemia High-dose inotropes	Sedation Muscular paralysis Hyperventilation High level of O2 Inhaled NO

Early Results of Surgical Treatment

- Hospital mortality rate: nearly 0%
  - Very low-weight or very young
  - Elevated PVR
- Complete AV dissociation: 0.5% to 3%
- Residual VSD
  - Suture dehiscence in small infants with friable myocardium
  - Small (<3m) ones close spontaneously over a period of months

Late Results of Surgical Treatment

- Normal or almost normal
  - Life expectancy, Growth and cardiac function
- Limitation in exercise tolerance
  - Persistant pulmonary HTN and increased PVR
- Mortality ↑
  - Correction after the age of 5 years, PVR > 7
  - Complete heart block


엉미~


OHTANI
17


SAMSUNG


KOR
10